CLAIMS

1. An abnormality diagnosis system for diagnosing a presence or absence of an abnormality of a bearing unit for a railway vehicle axle, comprising:

a sensing/processing portion for outputting a signal generated from the bearing unit as an electric signal;

a calculating/processing portion for making an abnormality diagnosis of the bearing unit based on an output of the sensing/processing portion;

a result outputting portion for outputting a decision result of the calculating/processing portion; and

a controlling/processing portion for feeding back a control signal to a control system of the railway vehicle based on the decision result.

2. An abnormality diagnosis system according to claim 1, wherein the calculating/processing portion includes

a data accumulating/distributing portion for accumulating the electric signal fed from the sensing/ processing portion and distributing the signal to an appropriate distributing route according to a type of the electric signal,

an analyzing portion for calculating a predetermined physical quantity in regarding to the bearing unit based on the electric signal distributed from the data accumulating/ distributing portion,

a first data saving portion for saving bearing unit data in regarding to the bearing unit,

a comparing/deciding portion for making the abnormality diagnosis of the bearing unit by comparing/referring an analyzed result of the analyzing portion with the bearing unit data saved in the first data saving portion, and

a second data saving portion for saving the analyzed result of the

analyzing portion and a decision result of the comparing/deciding portion.

3. An abnormality diagnosis system according to claim 2, wherein the analyzing portion includes

a filtering processing portion for removing a noise component of the electric signal fed from the calculating/ processing portion or extracting a particular frequency component to output, and

a frequency analyzing portion for executing a frequency analysis of a signal output from the filtering processing portion, and

the comparing/deciding portion makes the abnormality diagnosis of the bearing unit based on a result of the frequency analysis of the frequency analyzing portion.

4. An abnormality diagnosis system according to claim 2 or 3, wherein the analyzing portion has a temperature analyzing portion that calculates a temperature of the bearing unit based on the signal output from the data accumulating portion, and

the comparing/deciding portion makes the abnormality diagnosis of the bearing unit based on the temperature calculated by the temperature analyzing portion.

5. An abnormality diagnosis system according to any one of claims 2 to 4, wherein the analyzing portion has a rotation analyzing portion that calculates a rotation speed of the bearing unit based on the signal output from the data accumulating portion, and

the comparing/deciding portion makes the abnormality diagnosis of the bearing unit based on the rotation speed calculated by the rotation analyzing portion.

6. An abnormality diagnosis system according to any one of claims 1 to 5, wherein the calculating/processing portion outputs data saved in the second data saving portion to the controlling/processing portion in response to the abnormality diagnosis result.

7. An abnormality diagnosis system according to any one of claims 1 to 6, wherein the filtering processing portion extracts only a frequency component of 1 kHz or less.

8. An abnormality diagnosis system according to any one of claims 1 to 7, wherein a sensing element of the sensing/ processing portion is arranged on a stationary portion of the bearing unit in a loading range.

9. An abnormality diagnosis system according to any one of claims 1 to 8, wherein the data accumulating/distributing portion does not output the electric signal containing a noise component, which exceeds a predetermined level, to the analyzing portion.

10. An abnormality diagnosis system according to any one of claims 1 to 9, wherein the comparing/deciding portion makes the abnormality diagnosis of the bearing unit by comparing levels of a frequency due to the abnormality and its higher harmonics with a reference value.

11. An abnormality diagnosis system according to any one of claims 1 to 10, wherein the comparing/deciding portion decides that the abnormality is generated when at least one of peak values of the frequency due to the abnormal and its higher harmonics is larger than a predetermined reference value.

12. An abnormality diagnosis system according to any one of claims 1 to 11, wherein the comparing/deciding portion estimates a degree of damage of the bearing unit based on the peak values of the frequency due to the abnormal and its

higher harmonics.

13. An abnormality diagnosis system according to any one of claims 1 to 12, wherein the comparing/deciding portion makes the abnormality diagnosis by comparing the levels of the frequency due to the abnormal and its higher harmonics.

14. An abnormality diagnosis system according to any one of claims 1 to 13, wherein the comparing/deciding portion makes the abnormality diagnosis based on a square mean or a partial overall of a frequency band containing the frequency due to the abnormal.

15. An abnormality diagnosis system according to any one of claims 1 to 14, wherein the comparing/deciding portion makes the abnormality diagnosis by applying a cepstrum analysis to a frequency spectrum.

16. An abnormality diagnosis system according to any one of claims 1 to 15, wherein the signal is transmitted between the sensing/processing portion and the calculating/processing portion and the calculating/processing portion and the controlling/processing portion via a cable that has waterproof, oil-resistant, dustproof, rust-preventive, and moisture-proof functions, and heat-resistant, voltage-proof, and electromagnetic noise-resistant properties respectively.

17. An abnormality diagnosis system according to any one of claims 1 to 15, wherein a radio communicating device is provided to the sensing/processing portion and the calculating/ processing portion and the calculating/processing portion and the controlling/processing portion respectively, and the signal is transmitted therebetween by using the radio communicating device via radio.

18. An abnormality diagnosis system according to any one of claims 1 to 15, wherein the signal is transmitted between the sensing/processing portion and

the calculating/processing portion and the calculating/processing portion and the controlling/processing portion via the cable that has waterproof, oil-resistant, dustproof, rust-preventive, and moisture-proof functions, and heat-resistant, and electromagnetic noise-resistant properties respectively, or the signal is transmitted therebetween by using the radio communicating device.

19. An abnormality diagnosis system according to any one of claims 1 to 18, wherein the abnormality diagnosis is made in real time.

20. An abnormality diagnosis system according to any one of claims 1 to 18, wherein the abnormality diagnosis is made at a time different from a vehicle traveling time, based on data accumulated in the accumulating portion .

21. An abnormality diagnosis system according to any one of claims 1 to 20, wherein the presence or absence of the abnormality of a bearing in the bearing unit and an abnormality occurring location are diagnosed.

22. An abnormality diagnosis system according to any one of claims 1 to 20, wherein a flat portion of a wheel is diagnosed.

23. An abnormality diagnosis system according to any one of claims 1 to 20, wherein the presence or absence of the abnormality of a gear in the bearing unit and an abnormality occurring location are diagnosed.

24. An abnormality diagnosis system for a machinery facility having a rotating body, comprising:

a sensor unit having a sensor fitted to a constituent parts of the rotating body to sense a physical quantity of the rotating body in a rotating operation;

a calculating/processing portion for deciding a presence or absence of an abnormality of the rotating body by analyzing an output signal of the sensor unit and then comparing an analyzed result with predetermined reference data; and

a controlling/processing portion for displaying the analyzed result of the calculating/processing portion and a decision result of the calculating/processing portion, and controlling an operation of the machinery facility in response to the decision result.

25. An abnormality diagnosis system according to claim 24, wherein the sensor unit has an output amplifying means for amplifying the output signal of the sensor.

26. An abnormality diagnosis system according to claim 24 or 25, wherein the sensor unit has a radio communicating means for transmitting the output signal to the calculating/ processing portion via radio.

27. An abnormality diagnosis system according to claim 26, wherein the calculating/processing portion and the controlling/processing portion are provided to a monitoring base station that is remote from the rotating body.

28. An abnormality diagnosis system according to claim 27, wherein the sensor unit is fitted to a bearing of a railway vehicle, and

the sensor unit diagnoses the abnormality of the bearing.

29. A machinery facility abnormality diagnosis system for sensing a presence or absence of an abnormality of a sliding member or a rotating body in a machinery facility, comprising:

a sensor unit having one of plural sensing elements for sensing a signal emitted from the machinery facility; and

a calculating/processing portion for executing a calculating process to decide the presence or absence of the abnormality in the machinery facility based on an output of the sensing element;

wherein the calculating/processing portion is composed of a

microcomputer.

30. A machinery facility abnormality diagnosis system according to claim 29, wherein the sensor unit is incorporated into the sliding member or the rotating body.

31. A machinery facility abnormality diagnosis system according to claim 30, wherein the microcomputer is fitted to the sliding member or the rotating body or a mechanism parts that supports the sliding member or the rotating body.

32. A machinery facility abnormality diagnosis system according to claim 29, wherein the microcomputer and the sensor unit are mounted on a single device board, and are fitted to the sliding member or the rotating body or a mechanism parts that supports the sliding member or the rotating body as a single processing unit.

33. A machinery facility abnormality diagnosis system according to any one of claims 29 to 32, wherein the calculating/ processing portion is installed in a single casing.

34. A machinery facility abnormality diagnosis system according to claim 33, wherein the sensor unit is arranged integrally in the casing.

35. A machinery facility abnormality diagnosis system according to any one of claims 29 to 34, wherein the sensing element senses at least one of temperature, vibration displacement, vibration speed, vibration acceleration, force, distortion, acoustic, acoustic emission, ultrasonic waves, and rotation speed.

36. A machinery facility abnormality diagnosis system according to any one of claims 29 to 35, wherein the calculating/ processing portion includes central processing unit, amplifier, analog/digital converter, filter, comparator,

pulse counter, timer, interruption controller, ROM, RRAM, digital/analog converter, communication module, and external interface.

37. A machinery facility abnormality diagnosis system according to any one of claims 29 to 36, wherein the calculating/ processing portion executes at least one process or more of calculation of feature parameters of a standard deviation and a peak factor, envelope detection, FFT, filtering, wavelet transform, short-time FFT, calculation of a feature frequency due to a defect of the rotating body and comparison/decision.

38. A condition monitoring method for a machinery facility having at least one of a rotating body and a sliding member, comprising the steps of:

analyzing a predetermined physical quantity of the machinery facility based on a signal generated from the machinery facility;

provisionally diagnosing a presence or absence of an abnormality of the machinery facility by comparing/allocating an analyzed result with information serving as references to decide whether or not the abnormality is present in the machinery facility, every first time period; and

diagnosing the presence or absence of the abnormality of the machinery facility and an abnormal location, by executing a total evaluation, which decides the abnormality when a number of times the abnormality is provisionally diagnosed exceeds a threshold value, after a comparison/allocation is executed predetermined number of times or based on a compared/allocated result obtained every second time period.

39. A condition monitoring method for a machinery facility having at least one of a rotating body and a sliding member, comprising the steps of:

analyzing a predetermined physical quantity of the machinery facility

based on a signal generated from the machinery facility;

provisionally diagnosing a presence or absence of an abnormality of the machinery facility by comparing/allocating an analyzed result with information serving as references to decide whether or not the abnormality is present in the machinery facility, every first time period; and

diagnosing the presence or absence of the abnormality of the machinery facility and an abnormal location, by executing a total evaluation, which decides a degree of the abnormality according to a number of times the abnormality is provisionally diagnosed, after a comparison/allocation is executed predetermined number of times or based on a compared/allocated result obtained every second time period.

40. A machinery facility condition monitoring method according to claim 38 to 39, wherein the signal is A/D-converted into a digital signal, then a process of analyzing a frequency of the digital signal is executed, and then a frequency component generated due to a damage of the machinery facility and calculated based on an operating signal of the machinery facility is compared/allocated with a frequency component derived based on actually measured data every first time period.

41. A machinery facility condition monitoring method according to claim 40, wherein the signal is subjected to an amplifying process and a filtering process.

42. A machinery facility condition monitoring method according to claim 40 or 41, wherein at least one of the rotating body and the sliding member of the machinery facility is any one of rolling bearing, ball screw, linear guide, and linear ball bearing, and the operating signal of the machinery facility is either a

rotation speed signal in the rolling bearing and the ball screw or a moving speed signal in the linear guide and linear ball bearing.

43. A machinery facility condition monitoring system for a machinery facility having at least one of a rotating body and a sliding member and using the condition monitoring method set forth in claim 38 or 39, comprising:

at least one sensing/processing portion for sensing a signal generated from the machinery facility;

a calculating/processing portion having a microcomputer that executes a calculating process to decide a condition of the machinery facility based on the signal output from the sensing/processing portion; and

a controlling/processing portion having at least one of a result outputting portion that outputs a decision result of the calculating/processing portion and a controller that feeds back a control signal to a control system of the machinery facility based on the decision result.

44. A machinery facility condition monitoring system according to claim 43, wherein at least one of the sensing/ processing portion and the microcomputer is installed into the rotating body and the sliding member.

45. A machinery facility condition monitoring system according to claim 43 or 44, wherein at least one of the rotating body and the sliding member is a bearing to which a radial load is applied, and

the sensing/processing portion is fixed in a radial load loading range of a bearing housing that is fitted onto a raceway ring of the bearing.

46. An abnormality diagnosis system for a railway vehicle bearing unit using the machinery facility condition monitoring system set forth in any one of claims 43 to 45.

47. An abnormality diagnosis system for a windmill bearing unit using the machinery facility condition monitoring system set forth in any one of claims 43 to 45.

48. An abnormality diagnosis system for a machine tool spindle bearing unit using the machinery facility condition monitoring system set forth in any one of claims 43 to 45.

49. A machine equipment abnormality diagnosis system comprising:

a sensing/processing portion having a sensor unit that is fixed to a bolt screwed into a housing of the machine equipment and outputs a signal generated from the machine equipment as an electric signal;

a calculating/processing portion for making an abnormality diagnosis of the machine equipment based on an output of the sensing/processing portion; and

a controlling/processing portion for feeding back a control signal to a control system of the machine equipment based on a result of the abnormality diagnosis.

50. A machine equipment abnormality diagnosis system according to claim 49, wherein the calculating/processing portion includes

the calculating/processing portion includes

a data accumulating/distributing portion for accumulating the electric signal fed from the sensing/ processing portion and distributing the signal to an appropriate distributing route according to a type of the electric signal,

an analyzing portion for calculating a predetermined physical quantity in regarding to the machine equipment based on the electric signal distributed from the data accumulating/ distributing portion,

a first data saving portion for saving machine equipment data in regarding

to the machine equipment,

a comparing/deciding portion for making the abnormality diagnosis of the machine equipment by comparing the physical quantity calculated by the analyzing portion with the machine equipment data saved in the inside data saving portion,

a second data saving portion for saving the analyzed result of the analyzing portion and a result of the abnormality diagnosis of the comparing/deciding portion.

51. A machine equipment abnormality diagnosis system according to claim 49 or 50, wherein the calculating/processing portion and the controlling/processing portion are composed of a microcomputer or an IC chip.

52. A machine equipment abnormality diagnosis system according to any one of claims 49 to 51, wherein the signal is transmitted between the sensing/processing portion and the calculating/processing portion or the calculating/processing portion and the controlling/processing portion without a wire connection.

53. A bearing unit including an inner ring having an inner ring raceway surface, an outer ring having an outer ring raceway surface, a plurality of rolling elements arranged relatively rotatably between the inner ring raceway surface and the outer ring raceway surface, and a retainer for holding rollably the rolling elements, whereby a bearing to which a radial load is applied is arranged in a bearing housing,

the bearing unit comprising:

an abnormality sensing means provided in a loading range of the bearing housing, for sensing an abnormality from at least one selected from a vibration

sensor and a temperature sensor installed/fixed in a single case.

54. A bearing unit according to claim 53, wherein a flat portion is provided to a part of an outer peripheral surface of the bearing housing on a loading range side, and the abnormality sensing means is fixed to the flat portion.

55. A bearing unit according to claim 54, wherein the abnormality sensing means is arranged on an outer diameter portion of the bearing housing on the loading range side in a center portion of a bearing width.

56. A bearing unit according to claim 53, wherein the abnormality sensing means is arranged on an outer diameter portion of the bearing housing on the loading range side in a width area of the inner ring raceway surface or the outer ring raceway surface.

57. A bearing unit according to any one of claims 53 to 56, wherein a case of the abnormality sensing means has a signal carrying means that sends out a sensed signal, and a decision result outputting portion that decides a presence or absence of the abnormality based on the signal sent out via the signal carrying means and output a decision result.

58. A bearing unit according to any one of claims 53 to 57, wherein the abnormality sensing means is embedded/fixed on a recess portion formed on the bearing housing, and then secured by molding a clearance between the abnormality sensing means and the recess portion.

59. A bearing unit according to claim 58, wherein the abnormality sensing means is fixed to the recess portion via a spacer.

60. A bearing unit according to any one of claims 53 to 59, wherein a filtering processing portion for removing an unnecessary frequency band from a vibration waveform from the vibration sensor, an envelope processing portion for

detecting an absolute value of a filtered waveform transferred from the filtering processing portion, a frequency analyzing portion for analyzing a frequency of a waveform transferred from the envelope processing portion, a comparing/collating portion for comparing a frequency generated due to a damage calculated based on a rotation speed with a frequency derived based on actually measured data, and a result outputting portion for identifying a presence or absence of the abnormality and an abnormal location based on a compared result in the comparing/collating portion are provided.